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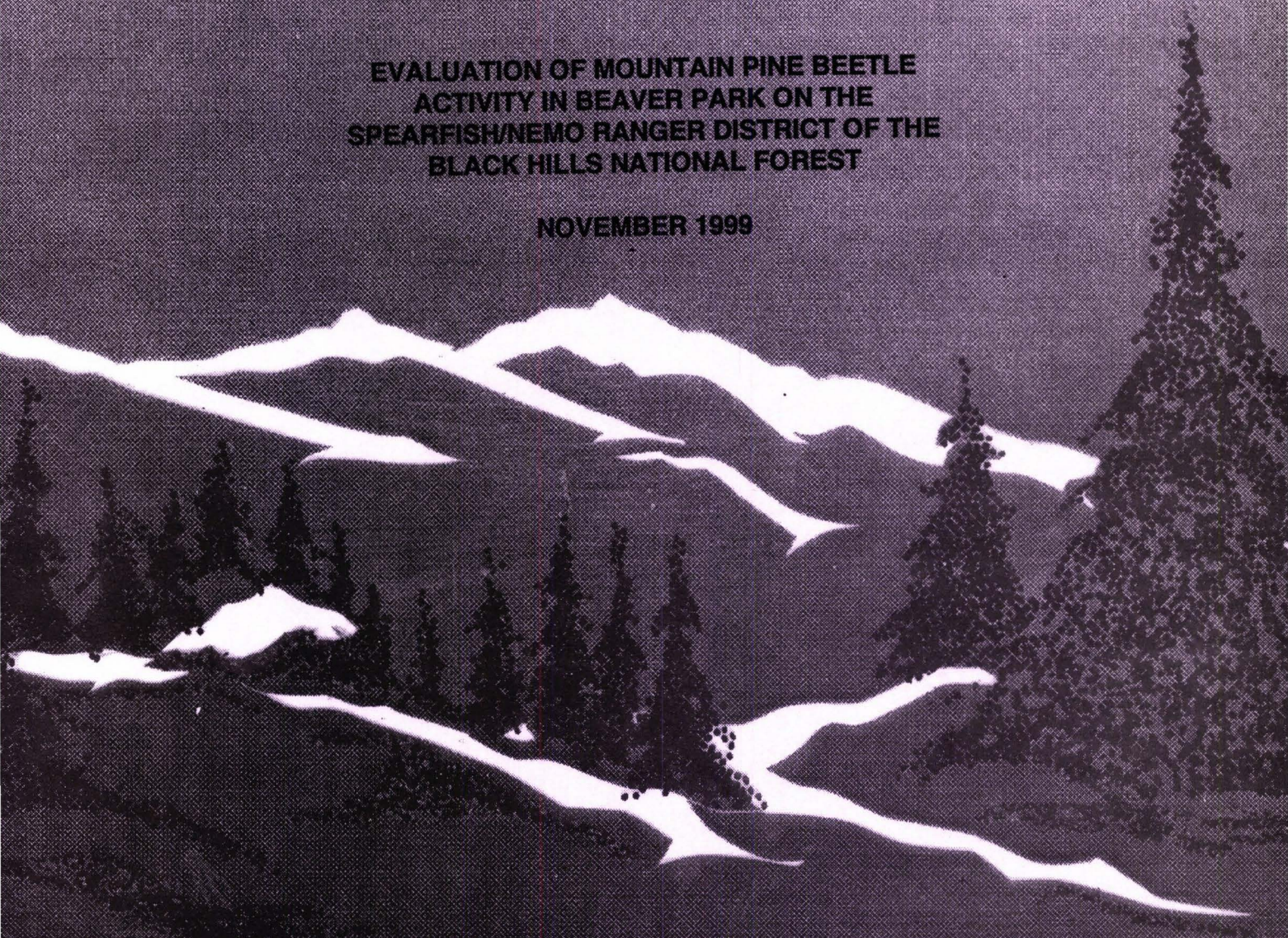
Forest Health Management

BIOLOGICAL EVALUATION
R2-00-01

EVALUATION OF MOUNTAIN PINE BEETLE ACTIVITY IN BEAVER PARK ON THE SPEARFISH/NEMO RANGER DISTRICT OF THE BLACK HILLS NATIONAL FOREST

NOVEMBER 1999



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NOVEMBER 1999

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ABSTRACT

Mountain pine beetle populations have been on the increase in the Black Hills over the last 2 years. The 1999 aerial survey detected a large mountain pine beetle infestation in the Beaver Park area on the Spearfish/Nemo Ranger District. Ground surveys indicate that there are an average 16.2 trees per acre killed over the last 3 years, with approximately 64% of these trees being currently infested. Also, brood sampling continues to indicate that beetle populations are still increasing in the area. In addition, nearly 70% of the forested land in the Beaver Park area is classified in the moderate to high stand susceptibility categories. Without treatment, there will be continued high levels of tree mortality in the Beaver Park area. Strategies for dealing with the mountain pine beetle include: do nothing, silvicultural treatments, sanitation/salvage harvesting, infested tree treatment and individual tree protection. The recommendation for the Beaver Park area is a combination of all tactics, to be used where appropriate, at this time.

INTRODUCTION

Mountain pine beetle (*Dendroctonus ponderosae*) is the number one insect killer of pines throughout the western United States. The beetle is a native species to the West and attacks most pine species including ponderosa pine in the Black Hills.

The mountain pine beetle has one generation per year in the Black Hills. Adult flight typically occurs sometime in July - August, when adults leave previously infested trees and attack uninfested, green trees. The adults attack green trees, chew through the bark and construct galleries along which eggs are laid. Larvae hatch from the eggs and begin feeding on the phloem of the tree in late summer to early fall. Larvae, pupae or callow adults overwinter under the bark of the infested tree. In the spring, the beetle finishes its maturation process, producing the next generation of adults.

Populations of the mountain pine beetle are usually found at an endemic level, killing and reproducing in stressed or weakened trees, including lightning strikes. Less than one tree per acre per year killed is considered to be an endemic level. For reasons that are not fully understood, beetle populations at times increase dramatically. In the increasing and epidemic stages, healthy trees are attacked and killed along with stressed trees. In 1998, areas of Beaver Park had tree mortality ranged between 102 trees per acre to 1.5 trees per acre killed over a three-year span (Allen and McMillin 1998).

The beetle has always been a part of the Black Hills forest ecosystem, with outbreaks occurring periodically. The first recorded outbreak in the Hills occurred from the late 1890's through the early 1900's and killed an estimated 1-2 billion board feet of timber. Outbreaks also have occurred in the 1930's, 1940's, 1960's and 1970's, each lasting 8-13 years with the 1970's outbreak being larger and causing more mortality than any of the others, except for the turn of the century outbreak. The most recent outbreak occurred from 1988-1992 in the Bearhouse Area on the Harney Ranger District and ended up killing over 50,000 trees (Pasek and Schaupp 1992). Outbreaks of the beetle can cause considerable changes in forested stands, including a reduction in average stand diameter and stand density (McCambridge et al. 1982). Mortality levels of 25% can be expected throughout the landscape surrounding outbreak areas and levels of up to 50% or more can occur in heavily attacked stands (McCambridge et al. 1982). The levels of mortality caused in an epidemic and the associated change in stand structure and composition can be undesirable: it reduces timber stocking levels, can affect wildlife habitat, can increase short term fire risks, and can negatively effect visual and recreation values.

Pine stands in the Black Hills can be categorized in their susceptibility to beetle attack. Generally stands are considered to be most susceptible when 75% of the stand is in the 7-13 inch diameter range and the stand density is over 120 feet of basal area per acre (Stevens et al. 1980, Schmid and Mata 1992). It should be noted that these general hazard rating guidelines and most stand inventory data are based on stand averages; small pockets that have high stocking levels within a low density stand can be a focal point for beetle buildup. Stand hazard ratings give an indication of which stands are

most likely to have initial beetle infestations. Once an outbreak has started, any stands containing suitable host material are likely to incur damage. These ratings also give no indication of local beetle pressure. However, hazard ratings can help to prioritize what stands should be treated to minimize beetle susceptibility. It also points out the best approach to reducing losses to the mountain pine beetle is forest management to reduce stocking densities. Stands that have stocking densities lowered will be less likely to have beetle outbreaks initiated in them, but it is a continuous process to keep them lowered. Recent work has shown that areas that are treated to 60 basal area can be expected to reach high hazard (120 basal area) again in about 25-50 years. Stands treated to 80 basal area can reach 120 basal area in 13-36 years, and stands treated to only 100 basal area will be back to 120 basal area in 9-16 years (Obedzinski et al. 1999). These timeframes of when a forest can increase in hazard level are relatively short, often shorter than typical time intervals between stand re-entries.

Other forms of control of mountain pine beetle, such as natural enemies or environmentally related factors, are less predictable. Generally, when beetle populations reach outbreak proportions, natural enemies, such as birds and predaceous or parasitic insects, are not numerous enough to have a noticeable effect on the outbreak. Natural enemies are more important in limiting mountain pine beetle populations that are in the endemic phase (Bellows et al. 1998). Likewise, environmental factors cannot be counted on for lessening the outbreak. For instance, temperatures of -10° F can kill beetles in October but temperatures of -25° are needed by February (Schmid et al. 1993). These temperatures would need to be reached under the bark, in the phloem, as opposed to air temperatures. Beetles survive low temperatures by removing water from within their cells and replacing it with glycoproteins, which act as a type of anti-freeze (Bentz and Mullins 1999). This is a process known as cold hardening. Beetles can have supercooling points, the temperature at which ice crystals start to form in body tissues, as low as -32° F in January (Bentz and Mullins 1999). Phloem temperatures become equal to air temperatures only when they persist for 24 hours or more (Schmid et al 1993). Generally, phloem temperatures are found to be 5 to 10° warmer than air temperature.

The focus of this evaluation is to examine the continuing beetle situation in the Beaver Park area of the Black Hills National Forest.

METHODS

The current mountain pine beetle conditions for the Beaver Park area were estimated using aerial survey data, brood sampling, and ground transects to estimate beetle caused mortality, including green currently infested trees, over the last three years. Stand hazard ratings for the Beaver Park area using the RIS database were reported last year and were not repeated (Allen and McMillin 1998). It is assumed that with the extensive tree mortality that overall the number of stands in the high and moderate classes have decreased.

The aerial survey was conducted in late August 1999. The number of fading trees and their approximate location were mapped. These surveys detect pines that have been killed in the last 1-2 years and whose crowns have faded. Currently infested trees, whose crowns have not faded, cannot be discerned from the air.

Brood sampling was carried out in April, June and November 1999 according to methods described by Knight (1960). A 6 x 6-inch piece of bark was removed from the north and south sides of currently infested trees. All live brood in the pieces were counted. A total of 15-20 trees were sampled in each area and the numbers of brood found were totaled for the area. This number can then be used in a regression equation to indicate whether beetle populations are decreasing, increasing or static.

Transect lines were run throughout the Beaver Park area in September and October 1999. Each transect line was approximately 1 mile long and 1 chain wide, covering an area of 8 acres per line (except where noted). Recently killed trees were tallied along each transect line. Attacked trees were broken into four categories:

New beetle hits - 1999 (green trees),
One year old hits - 1998,
Two year old hits - 1997,
Current pitchouts.

A total of 39 transect lines were run, covering 41.75 miles throughout the Beaver Park area, for a total of 334 acres evaluated. On each line, variable radius prism (BAF 10) plots were measured every 1/4 mile. Diameter at breast height (DBH) was taken for all "in" trees in each plot. These measurements were used to provide an estimate of basal area (BA) and DBH along the transect lines. The distribution of transects lines in the Beaver Park area is shown in Figure 1.

RESULTS

During the mid-1990's, beetle mortality was light and scattered throughout the Black Hills. In 1997, there was a noticeable increase in mortality detected. The 1999 survey showed another sharp increase from 1998, with much of the heaviest damage concentrated into a few areas. The aerial survey from 1999 detected a total of 25,562 trees killed throughout the Black Hills. This is an increase from the 10,726 trees killed on National Forest lands in 1998. In both cases, much of the damage was concentrated in groups of 25 trees or more in a few areas. More than 60% of the total tree mortality recorded in the 1999 aerial survey was found within the Beaver Park area.

Results from brood sampling are shown in Figures 2, 3, and 4. Figures 2 and 3 represent brood that was developing from beetle attacks initiated in August 1998. Figure 4 represents brood developing from attacks occurring in August 1999. In all cases, the data confirm that mountain pine beetle populations are increasing in the Beaver Park area. The decrease in the steepness of the slope in Figure 3 compared with Figure 2 is probably explained by additional mortality caused by natural enemies

and competition with wood borer larvae feeding on the same food resource. A similar decrease in this year's brood per sample is expected before beetle flight occurs in the summer of 2000.

Table 1 lists the number of beetle-killed trees found on all transects for the 1999 ground survey in the Beaver Park area. Mortality from 1997, 1998, and green infested trees show that there is an average of 16.2 trees per acre killed throughout this area. Although this value is slightly less than reported in last year's biological evaluation for the Beaver Park area (21.99 killed trees per acre, Allen and McMillin 1998), many additional stands were evaluated that included areas just beginning to experience tree attacks (e.g., transects T2, T27, T32) or had sanitation treatments initiated (transect 24). Beetle populations were increasing 2.5 times in both 1998 and again in 1999; that is, there were approximately 2.5 green infested trees for every 1-year-old killed tree. Therefore, the combination of increasing population and high number of trees being killed per acre characterize this area as being in an epidemic phase.

Table 2 lists the number of attacks by transects line in the Beaver Park area, and corresponding average basal area and diameter of trees along that line. Based on the 1999 aerial and ground surveys, the areas having the largest concentrations of beetles are located in Forbes, Beaver, and Bulldog Gulches. In particular, the south side of Beaver Gulch and north-central portion of Beaver Gulch has very large pockets, with some approaching 500 killed trees. The central portion of Forbes Gulch has even larger pockets of currently and previously infested trees, some in excess of 1000 trees (transect 18). The ground surveys also detected substantial numbers of currently infested trees on the south side of Forbes Gulch (transect 19). In addition, moderately large pockets of infested trees, 10-50 trees, can be found scattered throughout the remaining area. The average DBH ranged from 7.8 inches to 13.0 inches and the average basal area ranged from 95 to 175 square feet per acre. This combination of tree size and stand density provide suitably sized material for beetle infestation and are characterized as moderate to high beetle hazard.

Predicting mountain pine beetle spread and cumulative mortality over the course of an outbreak is difficult to do. The amount of mortality from our transect lines is conservative in that only mortality that has occurred in the last three years (1997, 1998, and 1999) was accounted for and the outbreak is not over, in fact it is intensifying. Obviously, there was some mortality in prior years that is not accounted for. Based on the last three years, however, the range of mortality on a line was from 1-34% of the average trees per acre. The lower end of the range is in the areas farthest away from the core infestation in the center of the Beaver Park Roadless area with the high end being where beetle activity has been the most intense over the last three years. The final impacts will not be known until the epidemic subsides and the mortality levels will certainly increase as beetle populations are still increasing.

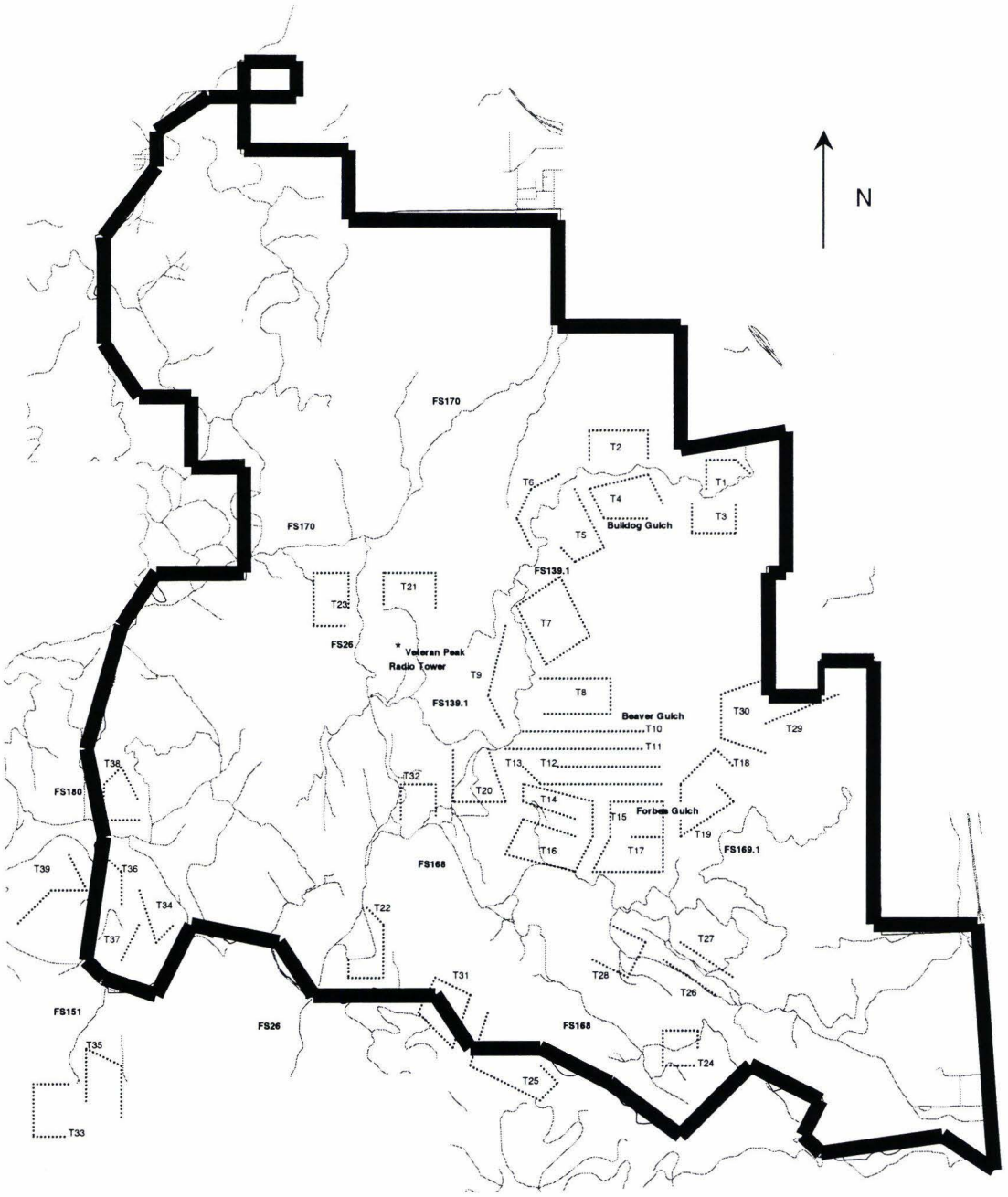

Fig. 1. Mountain pine beetle transect lines (dashed lines) relative to forest road system (light solid lines) and local landmarks in the Beaver Park analysis area (heavy solid line).

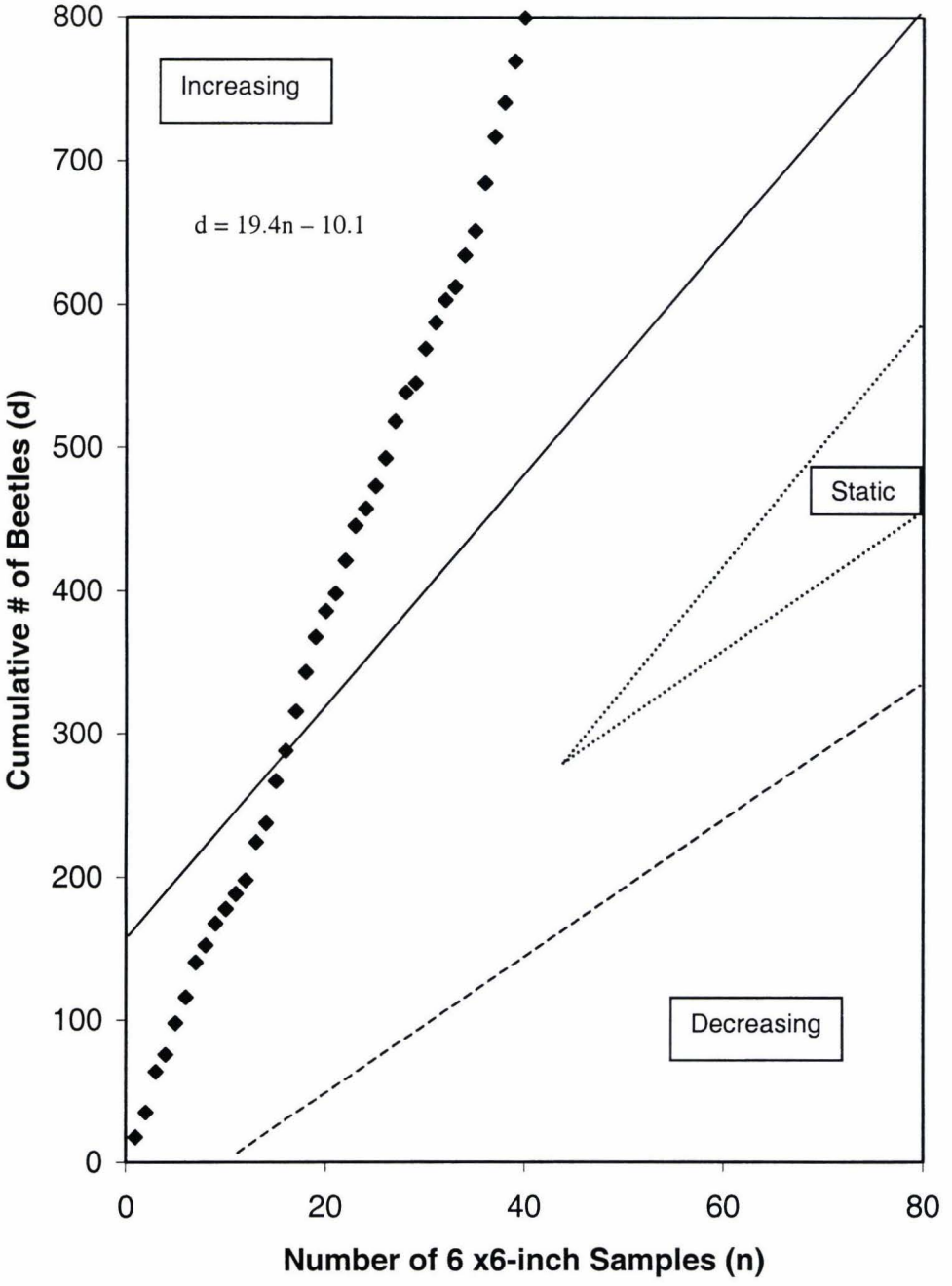

Figure 2. Sequential sampling of mountain pine beetle brood conducted on 28 April 1999. Data points are sample averages from four sites within the Beaver Park area.

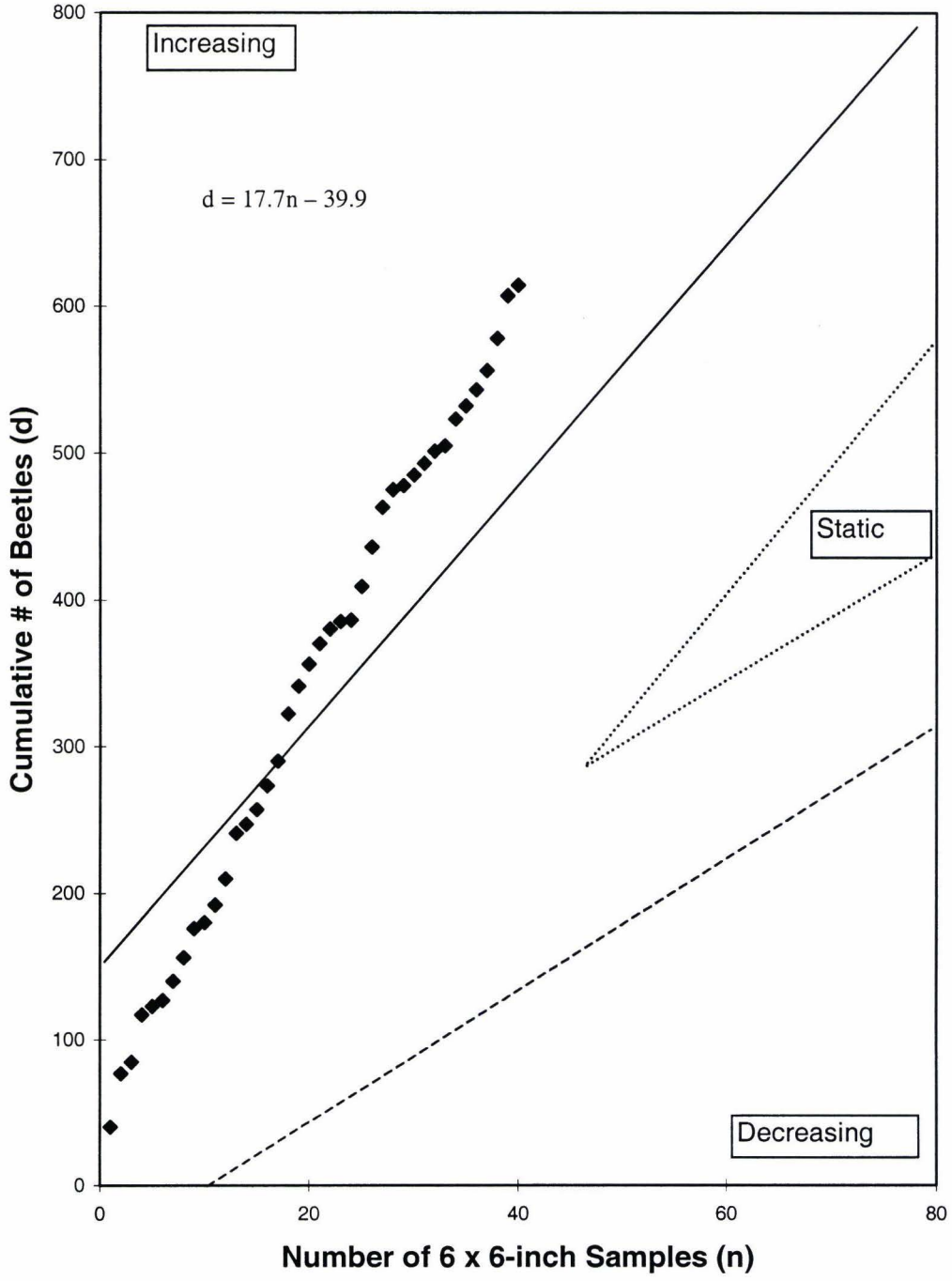

Figure 3. Sequential sampling of mountain pine beetle brood conducted on 18 June 1999. Data points are sample averages from two sites within the Beaver Park area.

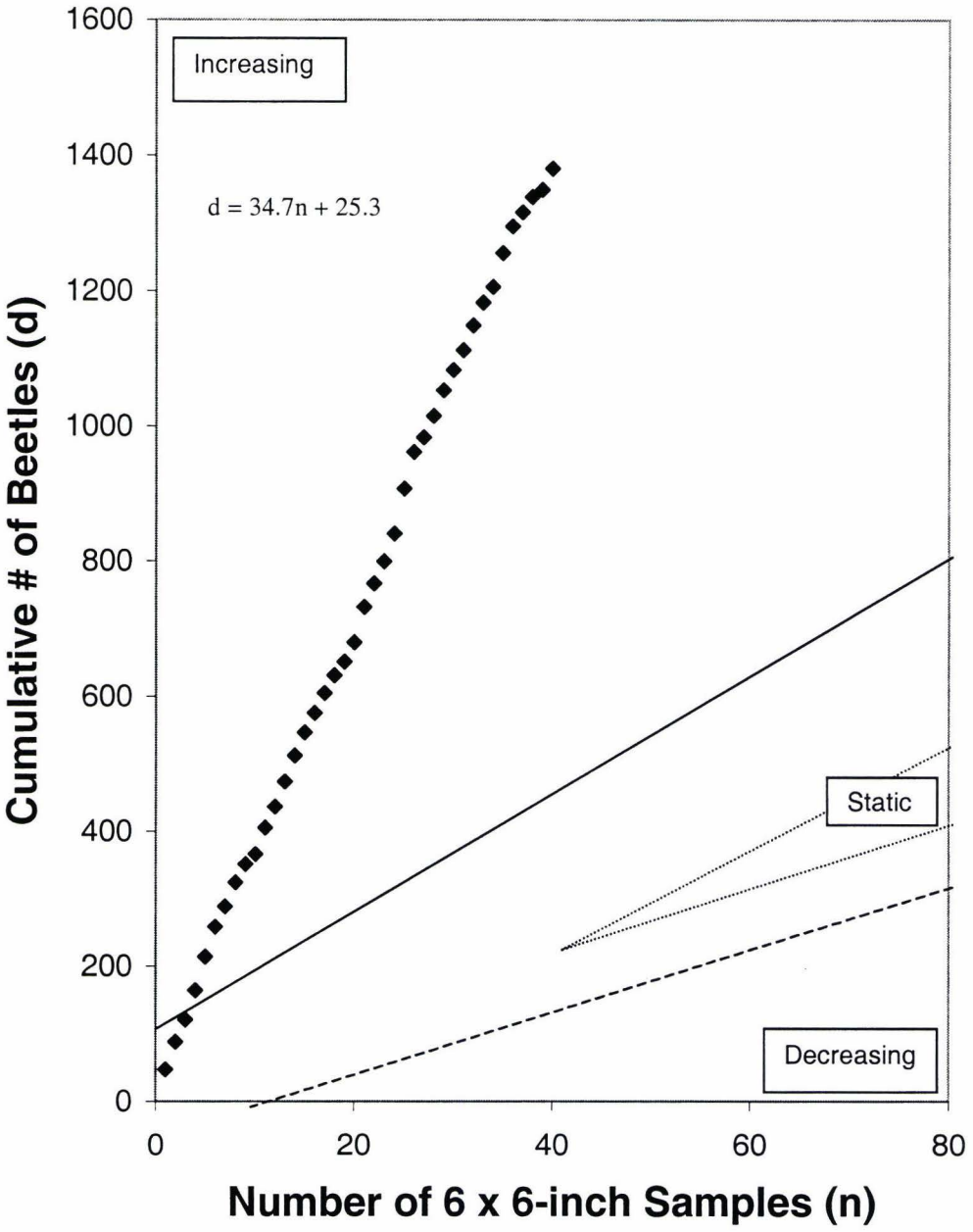

Figure 4. Sequential sampling of mountain pine beetle brood conducted on 15 November 1999. Data points are sample averages from four sites within the Beaver Park area.

Table 1. Number of mountain pine beetle attacked trees along 41.75 miles of transect lines in the Beaver Park Analysis Area, Spearfish Ranger District, and the ratio of attack frequency between years.

	Number of Trees Attacked	
Year	Total Trees Attacked (334 acres)	Attacked Trees Per Acre
1997 Dead	534	1.6
1998 Dead	1369	4.1
Green Infested	3440	10.3
1999 Pitchouts	67	0.2
All Attacks 1997-1999	5410	16.2

RATIO OF ATTACK FREQUENCY BETWEEN YEARS

1997:1998 -- 1:2.5

1998:1999 -- 1:2.5

1997:1999 -- 1:6.4

Table 2. Number of trees attacked per acre by mountain pine beetle along with average tree diameters and basal area by transect line in the Beaver Park Analysis area.

Line	Killed trees per acre, attacked in				Mean DBH	Mean BA	Mean Trees/Acre
	1997	1998	1999	Total			
1	0.8	1.0	9.6	11.4	10.6	160	260
2	0.8	0.3	2.6	3.7	10.2	175	298
3	2.7	2.7	3.3	8.7	10.3	130	162
4	10.7	15.1	29.4	55.5	12.0	134	207
5	8.5	16.8	20.9	46.2	11.5	140	247
6	1.3	1.4	10.9	13.6	12.1	133	177
7	1.3	3.6	12.9	17.8	10.2	145	246
8	0	0	0.8	0.8	10.8	128	192
9	4.8	7.0	4.3	16.1	11.6	155	198
10	0.8	3.1	8.0	11.9	10.3	98	100
11	0.4	0.6	8.5	9.5	11.5	120	177
12	0.8	3.9	16.4	21.2	11.2	103	149
13	0.9	1.8	5.9	8.6	10.4	157	256
14	0.3	1.4	5.1	6.8	10.1	107	177
15	4.2	12.4	12.7	29.3	9.9	117	219
16	0.1	3.0	5.6	8.7	12.0	103	127
17	0.4	1.5	3.8	5.7	13.0	120	144
18	8.0	23.7	51.5	83.2	11.6	162	245
19	2.1	7.9	43.3	53.3	12.0	153	184
20	0.8	5.5	3.9	10.2	12.4	123	153
21	0.4	0.4	0.2	1.0	10.0	116	239
22	0.1	1.5	12.5	14.1	7.8	158	500
23	2.6	3.6	8.0	14.2	10.4	98	193
24	0.8	3.5	2.0	6.3	12.1	158	192
25	1.8	7.4	10.1	19.3	12.2	121	114
26	1.0	6.6	15.5	23.1	8.1	128	211
27	0.1	0	0.1	0.2	10.2	103	176
28	0.1	3.3	4.3	7.7	9.8	140	302
29	0.5	1.8	6.4	8.7	11.7	118	164
30	1.3	6.5	27.8	35.6	11.3	145	214
31	0.3	1.3	7.4	9.0	12.5	105	133
32	0.1	0.1	1.0	1.2	12.8	113	143
33	0.3	0.5	1.0	1.8	12.6	173	191
34	0	0	3.8	3.8	12.0	95	152
35	0.2	0.2	1.2	1.6	13.0	133	137
36	0.8	5.6	17.9	24.3	10.4	105	223
37	0.2	0.8	4.7	5.7	10.3	110	204
38	0.8	2.4	15.3	18.5	9.9	130	232
39	0.4	1.6	4.3	6.3	11.1	108	168
Average	1.6	4.1	10.3	16.0	11.1	128	200

CONCLUSIONS

The high number of trees killed per acre and the year-to-year attack ratios found in Beaver Park are approaching numbers reported for previous outbreaks in the Black Hills. The number of trees per acre attacked in one year has been as high as 26.8, on the Spearfish District in the beetle epidemic of the 1970's (Creasap and Minnemeyer 1976) and 61.4 in the Bearhouse area in the early 1990's (Pasek and Schaupp 1992). Year-to-year attack ratios of 1:2 or 1:3 are fairly common in population buildups. There are spots in Beaver Park where almost every tree had been killed and many of them are green infested trees that will produce beetles next summer. The overall attack ratio from 1998 to 1999 was 1:2.5; however, there were a number of places where that ratio was much higher. Stand conditions in this area are also conducive to sustaining high levels of beetle caused mortality, as many stands are densely stocked with trees that are in diameter classes that the beetles prefer. All infested trees that were examined had live brood in them, mostly larvae. A general observation from the ground surveys was that there was some woodpecker activity throughout the area. Woodpeckers are a natural enemy of the beetles that eat the larvae as they are maturing under the bark. At this point it is unknown what percentage of the beetles will overwinter successfully; however, with the number of new attacks there should be plenty of new beetles to continue to fuel outbreaks in 2000.

Overall, MPB has reached outbreak proportions in the Beaver Park area. Currently, there are extensive pockets of mortality and the population is still building. Dramatic changes on the landscape have already occurred and additional changes can be expected in the next few years as mortality continues to increase. Any of the areas surrounding Beaver Park that contain suitable host material are also likely to sustain losses over the next few years. How high the mortality level will reach is hard to predict, however, in lodgepole pine forests, mountain pine beetle has caused greater than 90% mortality in trees over 5 inches in diameter in uncut (generally greater than 120 basal area) stands (McGregor et al. 1987). This certainly describes stand conditions in much of the Beaver Park area, although it is a different tree species. In ponderosa pine in the Black Hills, it was estimated that around 80% of susceptible trees had been killed in portions of the Bear Mountain area in the late 1980's and early 1990's (Pasek and Schaupp 1992). Again, stand conditions in this area were similar to those currently found in Beaver Park. McCambridge et al. (1983) found that greater than 50% of heavily attacked stands of ponderosa pine were killed in Colorado. The final totals for mortality in the Beaver Park should equal or surpass the 50% level in moderate or high risk stands, and more than likely will approach the 80% level. A final point on the Beaver Park area, which includes Veteran Peak, is that the town of Sturgis Municipal watershed and the Ft. Meade watershed are in this general area. If these areas sustain high levels of mortality, the effects on these watersheds are unknown.

ALTERNATIVES

There are a number of actions that can be used to reduce the impacts of mountain pine beetle in this area. These actions fall into two categories: direct action against the

beetles themselves or indirect action that addresses the general stand conditions. Direct action deals with the symptoms, too many beetles in one place at one time and are aimed at directly reducing the number of beetles present. Indirect action is aimed at the cause of the problem, which are stand conditions that are adequate for beetle buildup and outbreak.

The only effective long-range strategy to minimize beetle-caused mortality is controlling stand conditions silviculturally over entire landscapes and constant monitoring for areas of beetle buildup.

Alternative 1: No Action. Accept that MPB caused tree mortality and the impacts associated with it as a natural process. The extent of the damage to the stands in this area and surrounding areas is difficult to estimate, but there will be changes in the forest caused by beetles.

Where to use: Use where other alternatives are not desired or cannot be used.

Advantages: There is no mechanical site disturbance. There will be an increase in the amount of light getting to the forest floor, so that understory species and regeneration may be enhanced. Habitat for some wildlife species may be enhanced due to decreasing crown closure and creation of standing dead trees.

Disadvantages: This alternative allows beetle populations to increase and spread to other trees and surrounding areas. There is a loss in timber revenues from either not harvesting beetle-killed trees or letting the infestation grow and increasing the amount of killed timber. Fire hazards can increase with an increase in dead material, including red, dry needles. Visual and recreation values can be negatively affected. The loss of overstory tree cover can have a negative effect for some wildlife species. Regeneration can be impeded as dead trees fall and cover or shade the forest floor.

Alternative 2: Silvicultural Treatment. These are actions that increase tree vigor and reduce stand susceptibility to beetle attack. It is a preventative treatment that should be done prior to stands experiencing beetle outbreaks. In the Black Hills, stands that are less than 80 square feet of basal area per acre with average stand diameters of under 7 inches are at the lowest risk. When treating stands care must be taken to avoid leaving pockets of dense trees in an otherwise thinned stand.

Where to use: This is a preventative and should be used regularly when planning timber harvests. It is not a tool in stands currently experiencing a beetle outbreak.

Advantages: Silvicultural treatment can reduce overall stand susceptibility to beetle infestation. It does not guarantee that beetle caused mortality will be eliminated; it creates conditions that are less likely to experience a beetle outbreak. It maximizes the economic return from timber sales, as cutting is done prior to mortality taking place. The forest will experience mortality through time, treating stands silviculturally allows the decisions on what the forest will look like in the future through the types of harvesting done. If not, the beetles will decide what the forest will look like in the future through their actions, and this may be considerably different than what is desired.

Disadvantages: This action is not suitable for areas where timber harvest is not feasible. There is the site disturbances associated with timber harvest while the cuffing is being done.

Alternative 3: Sanitation/Salvage Harvest. Sanitation harvesting involves removing currently infested pines prior to the beetles maturing and leaving to infest new trees. It requires the removal of green trees that have live brood in them. These green trees are already dead, however, the foliage will not change color until the following summer. Trees removed in a sanitation harvest are treated, either moved to at least one mile from the nearest live host type or processed at the mill, prior to beetle emergence. Salvage harvest involves the removal of beetle-killed trees that do not have live beetles in them. These trees have already changed color; their needles are either red or gone.

A relatively new, and largely experimental, approach to the sanitation of bark beetles includes the use of semiochemicals (e.g., pheromones produced by the beetles for aggregation or anti-aggregation behavior). One method that is used in combination with traditional sanitation practices involves baiting trees with aggregation pheromones in concentrated areas or on a grid system just prior to the adult flight period. After the trees are infested, the trees **must** be removed and treated as stated above. A spillover effect (i.e., trees adjacent to the baited trees are also attacked) is commonly experienced when using this technique, and these neighboring trees also must be removed and processed if attacked.

Where to use: Stands susceptible to MPB that are currently under attack where it is desirable to reduce MPB populations and recover timber resource value. Also appropriate where beetle populations threaten currently uninfested nearby stands.

Advantages: MPB populations can be reduced in localized areas and in individual stands by removing most of the currently infested trees. This can provide some protection to surrounding uninfested trees and stands by removing a large source of attacking beetles. Timber values are recovered that would otherwise be lost or degraded. Fuel loading and fire hazard can be reduced by removal of much of the dead needles and timber. Regeneration can be enhanced through overstory removal and site disturbance.

Disadvantages: This alternative has a short implementation time. Areas must be marked and cut prior to beetle flight, July - early August in the Black Hills. Sanitation will not be effective on a large scale. It is only effective at suppressing beetles at the stand level and so will not work on a landscape level or when there is a chance of beetles reinfesting the treated area. Site disturbance that accompanies timber harvest occurs.

Alternative 4: Infested Tree Treatment. Cut and individually treat infested trees prior to beetle emergence. The action should kill most or all of the beetles within the cut trees. Examples of treatments include: cut and burn on site, cut and bury at least 6 inches on site, cut and chip, cut and debark. The use of beetle aggregation

pheromones could be used in conjunction with this option to contain beetle spots to be treated.

Where to use: This is most appropriate for treating small spots in areas where high value resources are nearby. It can be used in areas that are unroaded or too steep for conventional sanitation or salvage harvesting.

Advantages: Beetle populations can be reduced or eliminated from the treated area. This can provide some relief to surrounding uninfested stands and trees. The site disturbance is less than in conventional harvesting operations. Regeneration can be enhanced through the removal of overstory trees. Fire hazard can be reduced.

Disadvantages: The implementation time for this alternative is short. Treatments must be done after new infested trees are located and prior to beetle flight. This treatment only reduces beetle pressure in a small area; it is not effective on a landscape scale. This treatment does nothing to address stand conditions that led to beetle buildup in the first place.

Alternative 5: Protection of High Value Trees. Prior to beetle emergence in the summer, the stems of high value trees are treated with a registered insecticide.

Where to use: On trees around residences and in campgrounds. Trees must be of significantly high value and be under heavy beetle pressure to justify treatment costs.

Advantages: This action is very effective at protecting individual trees from becoming infested.

Disadvantages: Insecticide application does not effectively reduce beetle populations or address the cause of the outbreak. It does not guarantee protection; application must be thorough for it to be effective. Many people have concerns regarding environmental contamination when using pesticides. It is extremely expensive and, therefore, is only appropriate for a single or a few high value trees.

RECOMMENDATION

All alternatives are recommended depending on the site and suitability. The beetle population has risen to a point where any and all actions should be considered in this area or population spread will continue and cause mortality in surrounding areas.

The do nothing alternative may be chosen out of necessity in some of the most remote areas and those with steeper slopes. This alternative would allow continued beetle buildup and its associated mortality. This mortality may be extensive in some areas that go untreated.

Alternative 2, silvicultural treatments, is best used during long range planning processes. Stands in this area that can be manipulated need to have this done on a

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regularly scheduled basis to avoid future outbreaks. At this point, most of the silvicultural planning for the core of this area is too late. This would be most useful in nearby surrounding stands around the perimeter.

Alternative 3, sanitation and salvage logging is highly recommended in those areas where it is possible. Removal of beetle-infested trees would need to be carried out in a short time frame, before the middle of July 2000 when the beetles would start to fly. At the very least, these types of operations ought to be carried out around the perimeter of the infested area where beetle populations exist in an effort to confine the outbreak in the Beaver Park area. In some of the gulches within this area, sanitation/salvage logging may be difficult and would likely result in some areas that are clearcut, as there are some areas where basically every tree has been killed in the last few years or is currently infested.

Because of other considerations, use of infested tree treatments should be considered, especially in high profile areas. These treatments can be used to kill overwintering beetles, thereby reducing the emerging beetle population some. This alternative is probably not appropriate over the entire Beaver Park area, but could be very useful in localized spots. Consideration should be given to using mountain pine beetle aggregation pheromones in conjunction with these treatments.

The use of protective sprays should be used only in very high value areas. These sprays could also be used in conjunction with aggregation pheromones, although this would only be on an experimental basis.

If there are no treatments carried out in this area, beetle populations will continue to grow and mortality will increase. The extent of damage that will occur and how long it will continue are difficult to state at this point in time; however, stands that are in close proximity to this area will remain at risk. The forest in the core of the Beaver Park area has already been significantly affected and changed, and there is a good likelihood that this epidemic will continue to expand and cause similar damage in surrounding areas.

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